Middle Devonian Carbonate Rocks and Shales of North-Central Ohio[1]

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ABSTRACT. Middle and Upper Devonian marine strata are examined in quarries and natural exposures at six localities in Erie and Huron counties in north-central Ohio. The formations studied are the Lucas Dolomite, Columbus Limestone, Delaware Limestone, Plum Brook Shale, Prout Limestone, and Huron Shale. Lithologies and fossil contents suggest depositional settings ranging from open marine to tidal flat. Biostratigraphy indicates correlation of Columbus and Delaware limestones with the Onondaga Limestone and Marcellus Shale, respectively, of New York and with the Detroit River Group and Dundee Limestone, respectively, of the Michigan Basin.

OHIO J. SCI. 88 (1): 18-22, 1988

INTRODUCTION

This field trip provides an opportunity to examine some of the best exposures of Middle Devonian strata in north-central Ohio. Emphasis will be on primary and diagenetic lithologic features, on faunal assemblages, on the sequence of depositional settings that these record, and on interregional correlations. The carbonate rock and shale units examined reflect entirely marine deposition on the southeastern flank of the Findlay Arch. Dip is southeastward into the Allegheny Basin, and the sequence of field trip stops is broadly from north to south traveling diagonally down dip and thus up-section (Figs. 1 and 2).

Although the Middle Devonian of north-central Ohio has been studied by paleontologists and stratigraphers for many decades, correlations of it with strata in surrounding regions are still somewhat controversial.

FIELD TRIP ROAD LOG

Assembly point for the field trip is the parking lot of the Erie Blacktop Company on the west side of Ohio 101, 1.1 km (0.7 mile) southwest of the 101 exit from Ohio 2, approximately 6 km (3.7 miles) southwest of the center of Sandusky, Erie County.

Distance: km (mi) cum.	inc.	
0	0	Turn left (northeast) on Ohio 101.
0.8 (0.5)	0.8 (0.5)	Turn left into parking area for stop 1.

STOP 1. Venice Quarry. Columbus Limestone and Delaware Limestone. 4.2 km (2.6 mi) northeast of center of Castalia on Ohio 101, Margaretta Township, Erie County.

After parking, walk southwestward along the southeast side of the quarry to its southwest corner. Be careful when climbing down into the quarry; footing is a little treacherous.

On the southwest face of the quarry are exposed the upper 2.5 m of the Venice Member (Swartz 1907) of the Columbus Limestone and the lower 2 m of the Delaware Limestone. These two units are similar in appearance, each characterized by 5-10-cm-thick, irregularly wavy beds of gray or brownish-gray limestone. The Delaware

[1]Manuscript received 6 October 1987 and in revised form 10 December 1987 (#87-46).

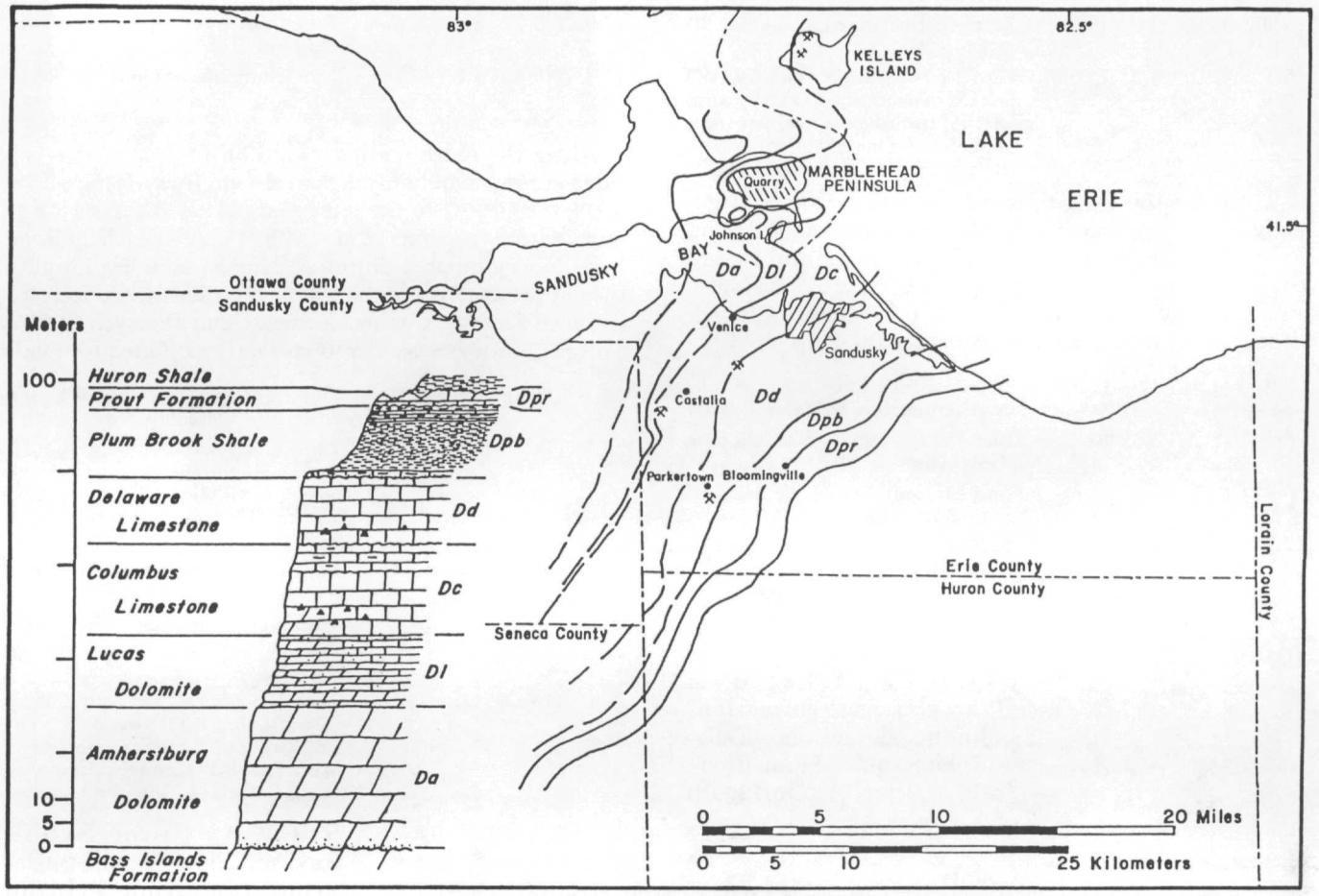

FIGURE 1. Stratigraphic column and outcrop belts of Devonian formations in field trip area. Figure by Dale R. Sparling.

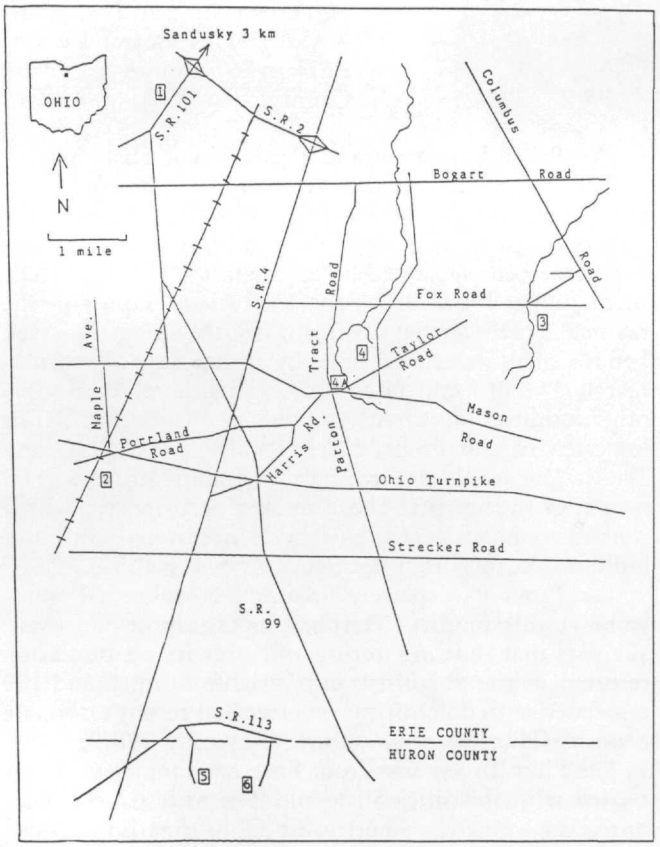

FIGURE 2. Map of field trip area showing roads referred to in the text. Field trip stops marked 1-6.

is more argillaceous and slightly browner than the Columbus. The Columbus-Delaware contact lies about 5 cm below a 2-5-cm-thick bentonitic layer that has been correlated with the Tioga Bentonite B of New York (Oliver 1967, Rickard 1984). This correlation, however, has been disputed by Sparling (1985) on the basis of conodont biostratigraphy, which suggests that the horizon of the Tioga Bentonite of New York is stratigraphically lower than this exposure. On the basis of macrofossils and conodonts, the Columbus is thought to be largely equivalent in age to the Onondaga Limestone of New York and to the Detroit River Group of northwestern Ohio and Michigan (Sparling 1985, Oliver 1976).

The Columbus-Delaware contact here is abrupt, disconformable, and locally conglomeratic. The uppermost Columbus is pyritic immediately beneath the contact with pyrite-filled burrows visible locally. Although there is no bone bed here, such as that reported elsewhere at this contact (Bownocker 1898, Swartz 1907, Stauffer 1909), both formations are profusely fossiliferous. The Delaware contains abundant echinoderm fragments, fenestrate bryozoan fragments, and some gastropods (*Bellerophon sp.*) and brachiopods (*Leptaena rhomboidalis, Stropheodonta demissa*). Rugose corals (*Hadrophyllum d'orbignyi*), brachiopods (*Spirifer duodenarius*), and crinoidal debris are common in the Columbus at this exposure. Its conodonts are of the *Tortodus kockelianus australis* zone, whereas those of the overlying Delaware are in the *Tortodus kockelianus kockelianus* zone (Sparling 1984, 1985).

1.9	(1.2)	1.1	(0.7)	Turn right (southwest) on Ohio 101 to Ohio 99.
5.1	(3.2)	3.2	(2.0)	Turn left (south) on Ohio 99, and proceed to point where Ohio 99 turns left 45° (southeast). Do *not* turn southeast on Ohio 99. Continue directly southward on Bardshar Rd.

The route southward toward the second stop is diagonally down dip. True dip is about 4 m per km (20 ft/mi) to the southeast away from the Findlay Arch and toward the Allegheny Basin. All remaining stops are to the south and/or east of Stop 1 and thus include exposures higher in the stratigraphic section than those at Stop 1.

7.0	(4.4)	1.9	(1.2)	Proceed southward on Bardshar Rd., to its termination at Mason Rd.
8.3	(5.2)	1.3	(0.8)	Turn right (west) on Mason Rd. to Maple Ave.
10.4	(6.5)	2.1	(1.3)	Turn left (south) on Maple Ave. and go to Portland Rd.
10.7	(6.7)	0.3	(0.2)	Turn right (west) on Portland Rd. and pass under Ohio Turnpike. Continue to Maple Ave. Almost immediately after crossing Maple Ave., Stop 2 will be on the left.

STOP 2. Parkertown Quarry. Lucas Formation, Columbus Limestone, Delaware Limestone, Plum Brook Shale. 6.4 km (4.0 mi) south of Castalia at Parkertown, Groton Township, Erie County.

This quarry exposes a much greater stratigraphic interval than that seen at the first stop. The full thicknesses of both the Columbus and Delaware are exposed here, as are the upper few meters of Lucas Formation below the Columbus and the lowest few meters of Plum Brook Shale above the Delaware. The Columbus here is about 18 m thick, and the thickness of the overlying Delaware is nearly 15 m.

The lower third of the Columbus at this locality is a lime mudstone containing corals (*Favosites, Cladopora, Cystiphyllum, Zaphrentis*) and stromatoporoids (*Stromatopora*) in its lower part and cherty zones in its upper part. Above this is a fossiliferous grainstone that makes up about another third of the formation's thickness. These units comprise the Marblehead Member as described and interpreted by Bjerstedt and Feldmann (1985) for several quarries to the north at Marblehead Peninsula and on Lake Erie islands.

The top third of the Columbus is a crinoidal mudstone that makes up the Venice Member (Swartz 1907) and is similar to the uppermost Columbus seen at Stop 1.

The overlying Delaware Limestone contains several thin shale beds in its lower half, where it is a crinoidal and locally cherty mudstone. The upper half is largely similar to the lower part, but also includes some bioclastic grainstones and, near the top, a local profusion of ramose corals (*Hadrophyllum*). The Delaware has been correlated with the lower Hamilton Marcellus Shale of New York (Stewart 1955, Sparling 1985) and with the Dundee Limestone of the Michigan Basin (Sparling 1985).

Effects of glacial disruption are strikingly clear on the east side of the quarry, where some strata of Delaware up to 5.5 m thick are locally tilted up vertically.

13.3	(8.3)	2.6	(1.6)	Turn right (east) on Portland Rd., and proceed to Ohio 4.
17.3	(10.8)	4.0	(2.5)	Turn left (north) on Ohio 4 to Bogart Rd.

Along the route northeastward on Ohio 4, there is a ridge approximately parallel to the highway lying about 0.8 km (0.5 mi) to the left (west). This is a sand ridge representing a former (Lake Whittlesey) beach of Lake Erie. It accumulated during a stand of lake level higher than at present, while the last of the Pleistocene ice caps dammed Lake Erie at its northeast end (Forsyth 1959). This particular beach ridge is currently exploited for sand.

22.1	(13.8)	4.8	(3.0)	Turn right (east) on Bogart Rd., and proceed to Columbus Ave.
23.6	(14.7)	1.5	(0.9)	Turn right (southeast) on Columbus Ave., and continue to the entrance to NASA Lewis Research Center. Stop here to gain entrance to the NASA base.
24.4	(15.2)	0.8	(0.5)	Continue southeastward on Columbus Ave. to Maintenance Rd.
24.9	(15.5)	0.5	(0.3)	Turn right (west) on Maintenance Rd., and proceed to the first road on the left.
26.0	(16.2)	1.1	(0.7)	Turn left (south) and, after 45 m (150 ft), turn right (west) on Short Cut Rd. Continue southwestward on Short Cut Rd. to intersection with Fox Rd. Park.

STOP 3. Plum Brook Ravine. Plum Brook Shale, Prout Limestone, Huron Shale. 9.7 km (6.0 mi) south of center of Sandusky, in NASA Lewis Research Center, Perkins Township, Erie County.

The Prout Limestone and Plum Brook Shale are exposed along the base of the ravine of Plum Brook, which trends north-south to the south of Fox Rd. Several 10s of meters south of Fox Rd., two 15-cm-thick carbonate mudstone beds separated by approximately 1 m of shale in the upper Plum Brook form very local rapids in the ravine. A little farther upstream (south) along the creek bed is a small waterfall formed by an exposure of approximately 1 m of Prout Limestone, which here, as in some other localities, apparently represents a carbonate flat or low area in the Prout depositional setting (Krywany 1982). Thicker Prout forming topographic highs will be seen later in the trip. These thicker occurrences, which contain abundant corals, have been interpreted as reefoid buildups on the Prout sea floor (Krywany 1982).

The Prout is a sparsely fossiliferous dolomitic mudstone at this locality. Petrographic study of the Prout suggests that shoaling during and after its accumulation resulted in the abnormal and variable salinity and pH associated with dolomitization of several recent carbonate deposits (Huntley pers. comm., Krywany 1982).

The Plum Brook and Prout have been tentatively correlated with the Silica Shale and Ten Mile Creek Dolomite, respectively, of northwest Ohio (Sparling 1985).

Immediately upstream from the Prout waterfall is an exposure of the lower part of the extremely fissile and organic-rich Huron Shale Member of the Ohio Shale.

27.1	(16.9)	1.1	(0.7)	Backtrack northeastward on Short Cut Rd. to its termination at T intersection.
27.6	(17.2)	0.5	(0.3)	Turn left (north) at T intersection and, after 45 m (150 ft), turn right (east) on Maintenance Rd. Proceed to Columbus Ave. The NASA headquarters building can be seen to the right across Columbus Ave. Park in the lot adjacent to the building. This is our lunch stop.
28.4	(17.7)	0.8	(0.5)	After lunch, turn right (northwest) from parking lot onto Columbus Ave., and return to NASA base entrance. Stop.
29.9	(18.6)	1.5	(0.9)	After leaving NASA base, continue northwestward on Columbus Ave. to Bogart Rd.
33.6	(20.9)	3.7	(2.3)	Turn left (west) on Bogart Rd., and proceed to Patten Tract Rd.
38.4	(23.9)	4.8	(3.0)	Turn left (south) on Patten Tract Rd., and go to intersection with Mason Rd. at Bloomingville.
38.6	(24.0)	0.2	(0.1)	Turn left (east) on Mason Rd., and continue to branch in road.
39.6	(24.6)	1.0	(0.6)	Take the left branch (Taylor Rd.), and proceed to Campbell St.
40.2	(25.0)	0.6	(0.4)	Turn left (north) on Campbell St., and continue to dead end. Park. The fence immediately to the north marks the boundary of the NASA base that we just left.

STOP 4. Campbell Street Section. Plum Brook Shale and Prout Limestone. 9.7 km (6.0 mi) south of center of Sandusky, just outside NASA Lewis Research Center at its southwest corner, Perkins Township, Erie County.

The topographic high over which we have driven for the last 0.6 km (0.4 mi) since leaving Taylor Rd. is a carbonate buildup in the Prout Limestone. Just to the north-northwest, on either side of the fence marking the west edge of the NASA base, is another topographic high of similar origin. The lower area between these two topographic highs is on thinner Prout Limestone. Field and petrographic studies of such Prout occurrences (Krywany 1982) suggest that the thicker Prout represents reefoid highs, whereas the thinner Prout was deposited in deeper water areas between reefoid buildups. Perhaps the topography on the Prout sea floor during and immediately after its deposition was similar to what we see now.

Walk west 0.3 km (0.2 mi) along the north edge of the cultivated field. Turn right (north), and descend into the ravine of a small tributary to Pipe Creek. Be careful to avoid an open, abandoned well when approaching the base of the ravine.

About 0.3 m of lowest Prout Limestone is exposed forming a rapids in the creek bed. Immediately below this, Plum Brook Shale is also visible. The Prout here, as at the last stop, is a dolomitic mudstone apparently deposited in a low area adjacent to carbonate buildups. At this locality the Prout contains silicified crinoid columnals, and thin-section study of Prout samples collected here reveals thin laminations (Krywany 1982).

Although the uppermost cherty zone of the Prout is not exposed here, there is an abundance of chert float that can be seen along the north edge of the cultivated field as we return to the vehicles.

40.8	(25.4)	0.6	(0.4)	Go south on Campbell St. to Taylor Rd.
41.5	(25.8)	0.7	(0.4)	Turn right (west) on Taylor Rd., and proceed to the Parker residence on the right (north) side of the road. Park.

STOP 4A. Optional supplementary stop. Parker Section. Plum Brook Shale. 10.5 km (6.5 mi) south of center of Sandusky and 0.6 km (0.4 mi) northeast of center of Bloomingville, Oxford Township, Erie County.

Walk northwestward behind the Parker residence along the tributary to Pipe Creek to the small bridge over the ravine. Descend on the west side of the bridge, and proceed downstream (west) for approximately 9 m to exposures.

Here, in the upper part of the Plum Brook Shale, are exposed the same two 15-cm-thick carbonate mudstone beds separated by approximately 1 m of shale that were visible at Stop 3 on the NASA base. Upstream (eastward) on the other side of the bridge, the Prout Limestone is present.

42.0	(26.1)	0.5	(0.3)	Leave the Parker residence traveling west on Taylor Rd. to intersection with Patten Tract Rd. in Bloomingville.
42.2	(26.2)	0.2	(0.1)	Continue westward past intersection with Patten Tract Rd. to Harris Rd.
45.7	(28.4)	3.5	(2.2)	Turn left (southwest) on Harris Rd., and continue to intersection with Ohio 4.

For approximately 3.2 km (2.0 mi) after turning onto Harris Rd., we will be traveling over Prout Limestone deposited as a carbonate flat in somewhat deeper water than the reefoid buildups expressed as topographic highs, such as those seen earlier near Stop 4.

51.8	(32.2)	6.1	(3.8)	Turn left (south) on Ohio 4. Proceed southward to intersection with Ohio 113 at Strongs Ridge.
53.4	(33.2)	1.6	(1.0)	Turn left (east) on Ohio 113, and go to intersection with Fitch Rd.

Immediately after turning left (east) on Ohio 113, there is a Prout Limestone quarry on the right bearing a reefoid structure that was described by Stauffer (1909).

After turning onto Ohio 113, we will travel for approximately 1.1 km (0.7 mi) on a Lake Maumee III beach ridge, which, like the younger one seen earlier, accumulated along the shore of what is now Lake Erie during late Wisconsin time. The high elevation of lake level was caused by damming by the most recent Pleistocene ice cap, which was still present at the water edge immediately north of the lake. Because of the ice dam, drainage of the lake to the northeast as at present was prevented, and Lake Maumee drained southwestward

to the Mississippi River system via what is now the Wabash River valley of Indiana (Forsyth 1959).

54.2	(33.7)	0.8	(0.5)	Turn right (south) on Fitch Rd., and go 0.8 km (0.5 mi) to Stop 5.

STOP 5. Fitch Rd. Viewing Point. Prout Limestone outcrop belt. 6.4 km (4.0 mi) east of center of Bellevue, Lyme Township, Huron County.

This is a place from which we can view, at a distance, a portion of the Prout Limestone outcrop belt. Some of the topography seen may resemble that which existed here immediately after Prout deposition, in that the topographic highs represent reefoid carbonate buildups separated by intervening, lower carbonate mud flats as indicated by petrographic study of the Prout that is found here (Krywany 1982). The top of the Prout is a chert bed, which apparently is sufficiently resistant to erosion to have largely preserved original Prout topography. The next stop will be at Prout exposures within this outcrop belt.

55.0	(34.2)	0.8	(0.5)	Return northward on Fitch Rd. to Ohio 113.
56.5	(35.1)	1.5	(0.9)	Turn right (east) on Ohio 113. Proceed to unpaved country lane on right (Schaeffer farm house is on left).
57.5	(35.7)	1.0	(0.6)	Turn right (south) on unpaved lane, and proceed to Stop 6.

STOP 6. Schaeffer Section. Prout Limestone and Huron Shale. 7.2 km (4.5 mi) east of center of Bellevue, Lyme Township, Huron County.

Exposed here on the south bank of a drainage ditch is the uppermost Prout Limestone overlain by a few meters of the Huron Shale Member of the Ohio Shale. About 0.5 m of relatively unweathered Prout can be seen, but the base of the formation is not exposed.

The fine- to medium-grained dolomite of the Prout is commonly laminated and, here and there, laminae can be seen to wrap around silicified corals and crinoid columnals. Vertical and oblique fractures, locally pyrite-filled, can be seen in the lower part of this Prout exposure.

The top of the Prout here is an approximately 8-cm-thick, gently undulating chert bed in which ostracods are replaced by chalcedony. The contact with the overlying Huron Shale is irregular and pitted. Shallow depressions in this contact are filled with coarser detrital material at the base of the Huron. Fractures and solution depressions filled with siltstone seem to suggest paleokarst topography. Perhaps the chert bed is a silcrete that protected and preserved the original relief.

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